Rules of the TAC Challenge for Unmanned Aerial Vehicles 2022

1. Introduction

Tau Autonomy Center are pleased to announce the TAC Challenge for Unmanned Aerial Vehicles 2023, that will be held at Tau Autonomy Center, outside Stavanger, Norway.

The goals of this competition are to advance the state-of-the-art of Unmanned Aerial Vehicles by challenging multi-disciplinary teams of students to perform automatic and autonomous flight capability within and industrial environment and to foster ties between young engineers and the organizations involved in UAV technologies.

The competition has an ambition to provide real-world industry problems that help students understand where the cutting edge of technology within UAVs lies.

Competition Information

The official language of the competition is English.
The competition specific rules and information are defined in this competition handbook.

Competition theme

The competition is designed to replicate real-world industry problems. The challenges are provided by sponsors and contributors where some of the challenges are challenges faced by the drone industry today.

The 2023 competition focuses on the following elements;

- Industrial mapping for generation of Digital Twins
- Edge processing to enable efficient transfer of data capture from aircraft to the end-user
- Inspection and identification of anomalies by the use of Artificial Intelligence.
- Data processing and use of payload data to provide value
- Development and documentation of UAVs in line with aviation requirements
- Development and deployment of operational procedures
- Autonomous detection of safe landing site

Maximum Points awarded.

Table 1 - Points

Static Events	
Operational Procedures, SORA and Risk Management	50
Engineering Design	50
Dynamic Events	
Industrial asset mapping	50
Site mapping with autonomous landing	50

2. Technologies to be demonstrated

1. Automated data capturing and data processing
2. Methods for Artificial intelligence in image recognition and data processing to detect anomalies
3. Automated recognition of suitable landing site
4. Demonstration and documentation of the UAV robustness for failure, including e.g. fail-safes
5. Use of methods for fast transfer of payload data from UAV to end-user

3. Venue

The Tau Challenge will be hosted in the airspace at Tau Autonomy Center.

59.09246°N, 5.9101°Ø

Figure 1 Operational Area for operations at the competition

4. Administrative Regulations

Part A1 – Competition Overview

4.1.Competition Objective

4.1.1. The competition challenges teams of university students to conceive, design, fabricate, develop and compete with small Unmanned Aerial Vehicles.

4.2.Competition Procedure

4.2.1. The Competition consists of Dynamic and Static Events. The competition is organized in a single class. The event will be co-hosted with the TAC Challenge for subsea vehicles.

4.2.2. All teams are responsible for obtaining regulatory permits to operate their UAV in Norway. The competition organizers have ongoing dialogue with the Norwegian CAA, and will be able to assist the teams in obtaining necessary permits.

4.2.3. Scoring is awarded as described in Table 1 - Points

4.3.Flight Permits

4.3.1. The applicant needs to attain their own approval to operate the UAV from the Civil Aviation Authority. For questions and guidance regarding this subject, please contact

4.3.2. The competition will follow the rules for operating under the “Open” Category. Coordination will for any deviations will be handled between TAC and the Norwegian CAA.

4.4.Competition Information

4.4.1. The official language of the competition is English

Part A2 - Aircraft Eligibility

4.5.Student Competition

4.5.1. Vehicles entered into the competition must be conceived, designed and maintained by the student team members without direct involvement from professional operators or manufacturers

4.5.2. The student team may use any information from professionals or from academics as long as the information is given as a discussion of alternatives with their pros and cons.

4.5.3. Students should perform fabrication tasks where ever possible.

Part A3 Rules of Conduct

4.6.General Officials Authority

4.6.1. The officials reserve the right to revise the schedule of the competition and/or interpret or modify the competition rules at any time and in any manner that is, in their sole judgment, required for safe and efficient operation.

4.7.Instructions from officials

4.7.1. All team members are required to cooperate with, and follow all instructions from the officials.

4.7.2. Failure of a team member to follow an instruction or command directed specifically to that team or team member will result in 25 penalty points being deducted from the team's overall score.

4.7.3. In the event of unsportsmanlike conduct, 25 penalty points will be deducted from the team's overall score. A second violation will result in expulsion of the team from the competition.

Part A4 - General Requirements for the Teams & Participants

4.8.Participants

4.8.1. A university can register several teams

4.8.2. Teams which are formed with members from two or more universities are treated as a single team.

4.8.3. A team member may only be part of one team, work on one vehicle and take part in static and dynamic events for only one team.

4.8.4. Each team must have one team member identified as the team captain. The team captain is the main contact person for the officials during the registration process and the competition.

4.9.Insurance

4.9.1. Each team must provide proof of Insurance for a liability insurance in accordance with (EC) No 758/2004. That means you need to have third-party liability insurance covering at least 0.75 million SDRs

4.10. Forfeit for non-appearance

4.10.1. It is the responsibility of each team to be in the right place at the right time.

4.10.2. If a team is not present and ready to compete at the scheduled time, they forfeit their attempt at that event.

4.11. Team Briefing

4.11.1. All team captains and pilots on a particular day must attend the team briefing for that day.

4.12. Testing and Work Safety

4.12.1. Competition organizers are not responsible for the use of the vehicles outside of their competition.

4.12.2. The competition officials disassociate themselves from all activities of the teams besides their own competition and associated events.

4.12.3. All teams are advised to follow common practices and common sense when working on the aircraft and when operating the aircraft, before, during and after a competition.

4.12.4. Organizers reserve the right to disqualify a team registered for their competition in case of unsafe operating behavior, especially if the reputation of the competition, sponsors and other teams is compromised.

4.13. Charging

4.13.1. There will be a separated charging area on the competition site. Charging of main power batteries is only allowed inside this area.

4.13.2. No grinding, drilling, etc. is allowed in the charging area.

4.13.3. At least one team member who has knowledge of the charging process must stay with the batteries (s) during charging.

5. General Technical Requirements

T1 - General Design Requirements

5.1. Aircraft Configuration

5.1.1. The vehicle must be designed and fabricated in accordance with good engineering practices.

5.1.2. The vehicle must be a multi-copter type UAV designed in accordance with the regulations for operating in the Open Category.

5.1.3. Multiple UAVs may be used for a single assignment. All UAVs must maintain regulatory requirements and be operated on a basis of only one UAV operated per operator.

5.2. Aerial Robot Design Details

5.2.1. The aircraft must have a maximum characteristic dimension of 3.0 meters.

5.2.2. The Maximum Impact Energy shall be less than 34kJ

5.2.3. The system shall have a MTOM < 4kg

5.2.4. The competing team is open to use any available propulsion system for the competition. Fully electric drones are recommended for the ease of the Risk Assessment and approvals from the CAA.

5.3. RC Override

5.3.1. The aircraft must have a system that enable the Pilot in Command to override any automatic operation.

6. Technical Inspection

IN 1 – General

Technical Inspection Process

6.1.1. The technical inspection is divided into the following parts:
- Documentation Inspection
- Vehicle Scrutiny

General Rules

6.1.2. Each aircraft must pass all parts of technical inspection before it may participate in any dynamic event.

6.1.3. Passing the technical inspections is not a certification of complete rules compliance of the vehicle.

6.1.4. To accelerate the technical inspection process, the team must appoint one team member as Technical Responsible Person.

7. Static Events

7.1.Engineering Design Objective

7.1.1. The concept of the design event is to evaluate the student's engineering process and effort that went into the design of an aircraft, meeting the intent of the competition and applicable regulations from EASA.

7.1.2. Proprietary components and systems that are incorporated into the vehicle design as finished items are not evaluated as a student designed unit, but are only assessed on the team's selection and application of that unit.

7.2.Engineering Design Report

7.2.1. The EDR should contain a brief description of the overall vehicle with a review and derivation of the team's design objectives. Any information to scope, explain or highlight design features, concepts, methods or objectives to express the value and performance of the vehicle to the judges shall be included at the teams' discretion.

7.2.2. The EDR must not exceed eight pages, consisting of not more than five pages of content (text, which may include pictures and graphs) and three pages of drawings.

7.3.Design Spec Sheet

7.3.1. A completed one pager design spec sheet must be submitted at the competition.

7.4.SORA and Operational Procedures

7.4.1. A Complete SORA shall be provided by the participating teams that covers both Dynamic Events. This SORA will be part of the scoring.

7.4.2. An Operations Manual (OM) shall be provided by the participating team that covers necessary aspects of the team's operations. This OM will be part of the scoring.

7.5.JOURNAL PAPER

7.5.1. Each team is required to submit a journal-quality paper (written in English) documenting its project. This paper will be ranked by the Judges on a scale of 0 to 100 points depending on technical quality (0 points minimum for submitting a credible paper or for those not submitting a paper by the deadline). Papers are limited to 10 pages (including figures and references, if any). Font size shall be 12 point (serif font) with 14 point leading. The example format is provided as an addendum to the rules (see: Paper Format). Topics to be covered are detailed in a printable document found at: Paper Content. A file (<50 MB in size) in PDF format of your paper is due by June 1 of each competition year. Papers are to be uploaded by the due date via the website uploader.

8. Dynamic Events

The competition will be arranged outdoors. Please advise Norway have a lot of different weather, even in July.

Weather limitations for the competition:

Flights will be performed within the indicated weather limitations. All teams are responsible for the requirement of any stricter internal weather limitations. If a team is not able to operate within the maximum weather limitations for the competition, the flight can be delayed with points deducted.

Flight safety and operation within approvals is always highest priority!

Precipitation: Light rain

Wind speed average: 10 m/s

Maximum gust speed (10 minute): 12 m/s

8.1.The runs

The competition consists of two dynamic events.

Event # 1 – Industrial Site mapping

Scoring objectives:

Comparison of design model vs “as is” for fault/change detection.

Use of design architecture 3D model and compare to data collected and map / display differences

Identification and indication of several features from the structure, including Aruco markers and colored spheres.

Intended use for the 3D-model is the owner/operator of the industrial structure.

The Arena:

A 3D-modell of the structure will be provided by TAC.

The flight will be performed around the offshore helideck structure at NOSEFO.

This structure is a module that was previously located in the Nord-Øst Frigg field in the North Sea.

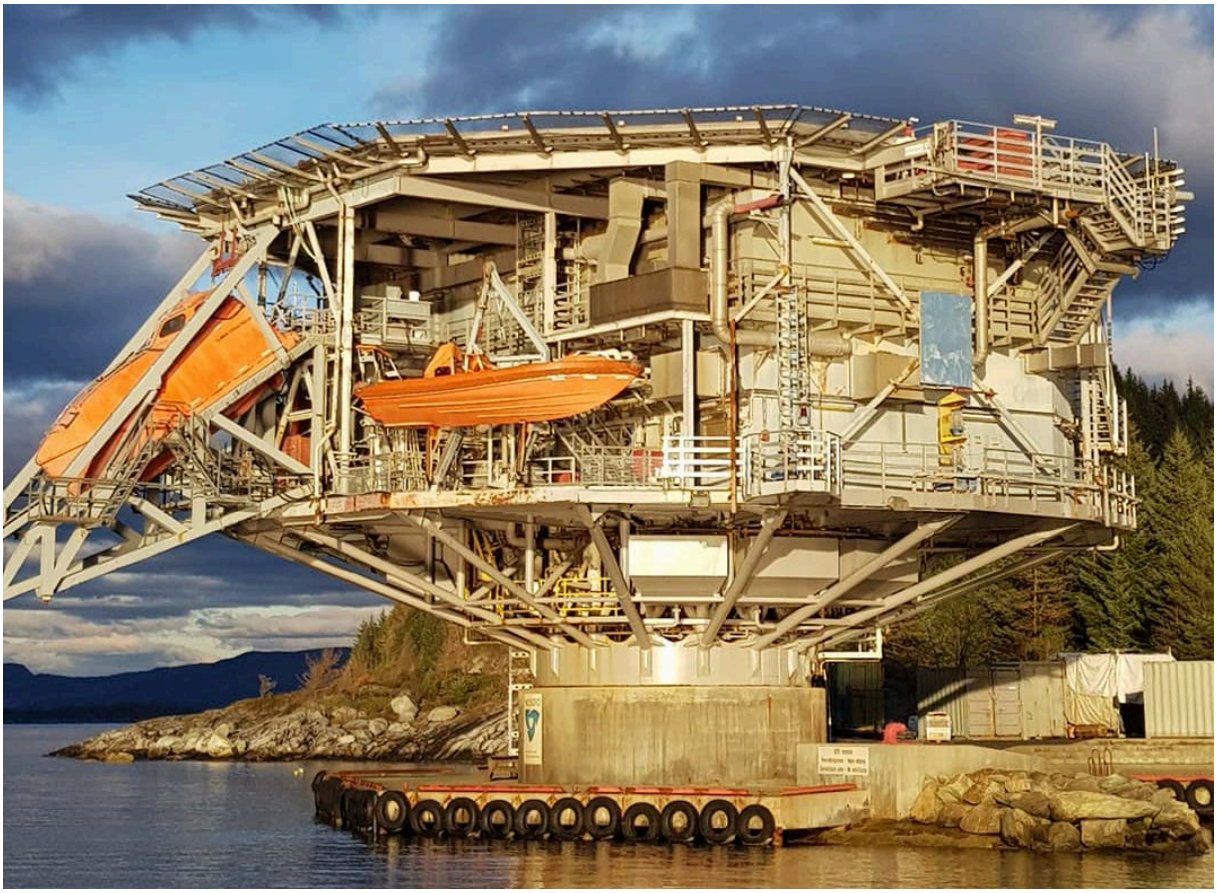

Figure 2 The Offshore Structure at Tau Autonomy Center.

The site will contain QR-codes or similar known structure placed on locations on the structure. These shall be identified by the UAV, and indicated in the provided 3D-model for anomalies.

Figure 3 Example of indicators that can be found on the structure.

The QR-codes will be from the dictionary DICT_5x5_50

- All Aruco tags on the structure will be unique.

In addition to the Aruco-codes, the structure will contain one or several colored spheres to be identified. These are of diameter 51cm, with white, red, yellow and blue sections.
https://www.ringo.no/produkt/beach-ball-51cm/

Event # 2 – BVLOS A-B flight with mapping and landing in site with unknown suitability

Mission Objectives:

The UAV shall perform the mission to provide near-real-time information of the terrain overflown.

After the mission has been completed. The UAV shall detect a suitable landing site within a specified area of 50 meter radius, and perform a landing out in the field for later extraction.

The UAV shall provide a point cloud of the entire green area.

> The reason for "near real-time" is that in the industry it is a problem that 3D scans are only available several hours after flight. The main objective of the mapping is to create a point cloud model of the terrain. There is no need to show it real-time, but it is a big plus.

The Arena:

Start of the mission will be from the helicopter deck. After performing a mapping mission of the Area, the UAV shall land within the blue circle.

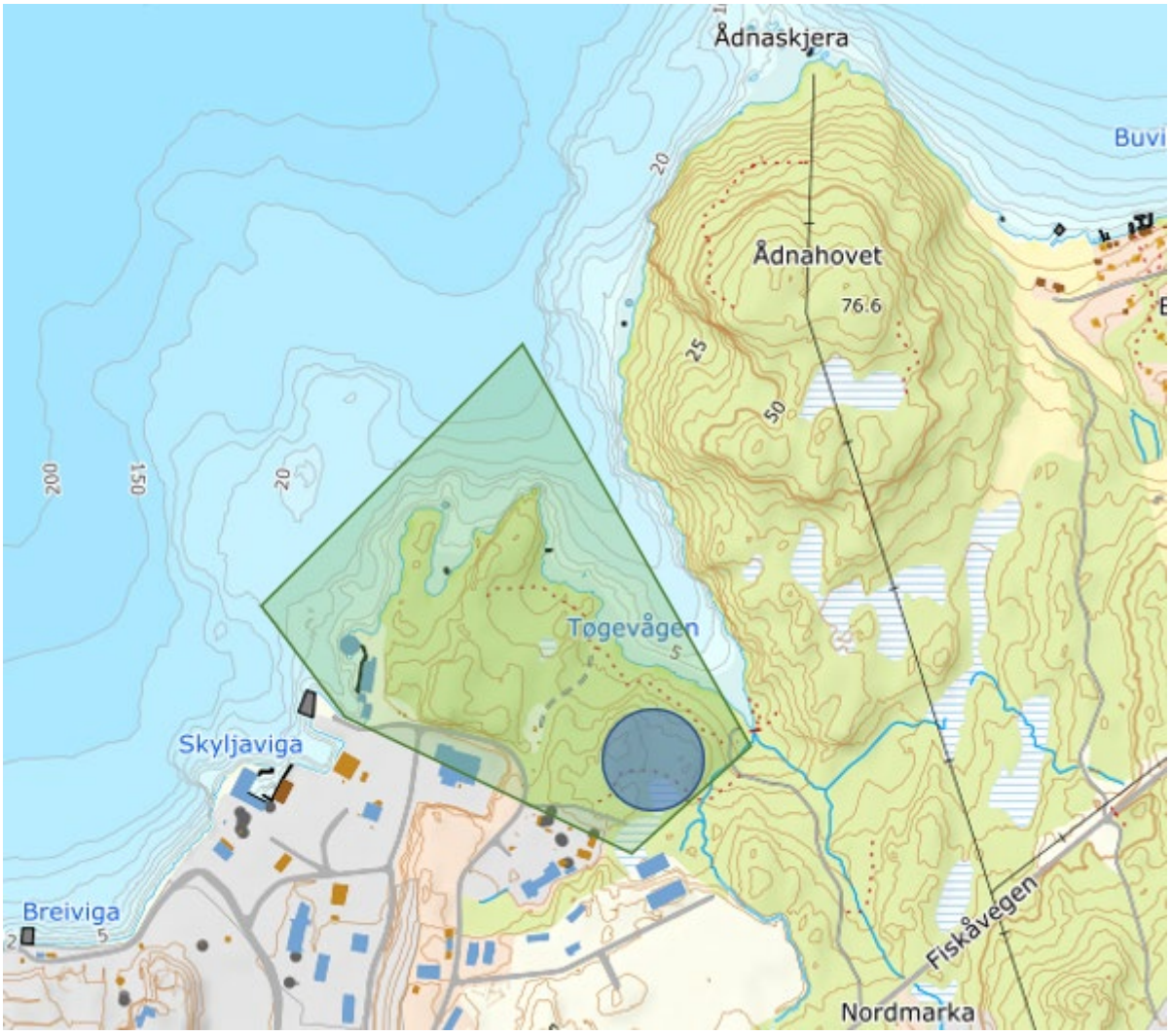

Figure 4 Operational Area for Event #2